

UK Innovation Potential in Advanced Water Treatment: Future Directions & Strategy

Participatory Workshop – Thursday 30th June, 2011

James Clerk Maxwell Building (JCMB), Teaching Studio 3217

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WORKSHOP REPORT

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EXECUTIVE SUMMARY

The below response to the twelve questions discussed by eight interdisciplinary groups during the water innovation workshop includes the breath of responses with some editorial comments (*in italics*). From those discussions a number of key issues have emerged;

- ◆ The need for a national test facility that enables access for spin offs, SMEs and academics to test advanced water technology innovations. While such a facility could be hosted by a water company, access should be affordable and open. A follow-on workshop will discuss how such a facility could be funded and what such a facility would ideally provide.
- ◆ Innovation funding in the water sector – and advanced water treatment technologies in particular – is widely held to be inadequate and places the UK knowledge base into a poor starting place for international competition. Research funding for the sector and funding models that support industry-academia partnerships, spin offs, SMEs and routes to market require a strategic revisit to enable UK talent at all levels and ultimately national benefits of job creation and a healthy position of the UK in the global marketplace. An important exercise may be to establish the actual research spend in the sector, a comparative analysis to leaders in the field (such as Singapore, Israel, Germany and Australia), enhanced communication of research in the sector and the impact of such research expenditure, in tandem with a clear water innovation strategy.
- ◆ Innovation in the water sector is fractured with potentially significant repetition and lack of a coordinated effort. Yet the broad knowledge base available in the UK is not exploited to its fullest potential by drawing inclusively on expertise from a multitude of providers and disciplines. Further a need for stronger policy-industry-academia partnerships has been emphasized as beneficial, where industry includes the supply chain and SMEs that are seen as major innovation drivers. Close interaction with international networks and possibly the creation of a focused UK advanced water innovation network will be discussions for a follow-on meeting.

A follow-on workshop with a tentative date in early December 2011 will be scheduled in due course with a set of well defined questions to move forward on discussions from this first workshop. Suggested questions and nominations for participation are most welcome.

APPENDICES

1. Workshop Program
2. Workshop Participants (Working Groups)
3. Presentation Dr Mike Walker, Defra
4. Presentation Matt Bower, DWQR
5. Presentation George Ponton, Scottish Water
6. Presentation Dr Jim Marshall, UK Water Innovation Hub
7. Presentation Prof Andrea Schäfer, Edinburgh University
8. Answers to Questions by Working Group (*unedited*)

The organizing committee would like to thank the workshop attendees for their enthusiastic participation in discussions during the day and making their way to the 'far north' for this workshop.

Question Set 1

- 1: State of the art in advanced water treatment technologies: What is the next generation of water treatment technology? Where are the innovation opportunities for the UK?

The question was aimed at the next generation of advanced water treatment technologies – where advanced water treatment was intended to cover water treatment (surface/ground/sea-water) as well as polishing stages of water reuse or recharge (and hence wastewater treatment). The aim of the question was to identify areas where the UK hosts expertise that may drive global innovation opportunities.

The somewhat conflicting drivers for innovation in advanced water treatment are 1) tightening standards in particular with regards to micropollutants / priority substances that require potentially more energy intense treatment as well as potentially changing water quality due to climate change, and 2) reduction in CO₂ emissions / energy savings and chemicals. Possible responses to this dilemma are to;

- 1) develop novel and more efficient water treatment processes that remove micropollutants effectively without increased energy demand (e.g. new advanced oxidation, catalytic filter materials, new adsorption and generation processes, smart & sustainable materials, nanotechnology, carbon nanotube membranes, electro-chemical processes, in-pipe treatment, cavitation, waste from other industries as treatment, low tech (stone media) as opposed to high tech (plastic), smart sand). The potential of cross-disciplinary innovations (biological membranes, medical applications) could reward inventions in the area and a 'back to basics' approach will be useful to develop new technologies from primary principles.
- 2) sensible integration of advanced water treatment into the water cycle (e.g. upstream management, wastewater treatment (reduced discharge), zero waste target in treatment, good risk management plans, point of use treatment, rainwater harvesting, greywater reuse, decentralized/off grid treatment and supply, point of generation, sustainable/appropriate technologies, water savings /efficiency (metering)).
- 3) risk management, process control and monitoring (e.g. real time pathogen sensing, good predictive tools of treatment processes, behavioural science, more effective water quality and leak detection systems).

As previously established (KTN), innovation opportunities are overseas and in consequence the UK has an opportunity to innovate and demonstrate technologies, with a global uptake potential. Balancing novel treatment processes, possibly simpler but using smart materials and appropriate use (as opposed to micropollutant free water for toilet flushing) is a challenge awaiting innovation.

- 2: How to manage the disconnect between increasing water quality standards (in particular micropollutants) and requirement to reduce carbon emissions?

This question was in part covered above in Q1. Discussions focused on four main areas;

- 1) Regulation and Standards; environmental risks, risk based approach (e.g. water management plans) over precautionary principle, better understanding and communication of actual micropollutant risk on human and environmental health, influencing EU policy, communication between regulator and industry on emerging issues, lack of critical drivers (nothing is important enough for water companies to change the way things are done; climate change is a driver on the horizon? EU Water Framework Directive for micropollutants?), are quality standards fit for purpose?, better detection, different standards for different water uses, risk-benefit analysis.
- 2) Accounting: carbon emissions and environmental impacts; life cycle assessment for treatment processes; knowledge of energy contributions of unit operations (rather than overall treatment plants only), improved energy efficiency and usage of renewable energy, capex dominates everything and discourages energy savings, energy self-sufficiency, green fleet, effective carbon market.
- 3) Source control; working with farmers regarding micropollutant release and the pharmaceutical industry (e.g. to produce more degradable drugs, drug authorization procedures, product use), catchment management, lead pipe replacement, time variant discharge content, efficient use of fertilizers/pesticides, societal problem rather than water industry, better education!
- 4) Treatment technologies that are delivered with renewable energy, rainwater harvesting (micropollutant free), urine separation (urine contains the lion's share of micropollutants from human source), water

recycling, treating less water, separate water systems (dual reticulation), more appropriate water usage (don't flush every time you pee). Private water supplies.

There was a perception that the risk adverse nature of the regulatory regime discourages step change and innovation. Reflecting on the Australian experience this may well be correct; dual reticulation systems have experience their teething problems through cross connections and such problems cannot always be foreseen. However, the UK has over a decade of experience in Australia (and other countries) to build on. A multiple barrier approach to treatment reduces risk which is of paramount importance in water recycling. Ultimately the discipline requires leaders that are willing to take (managed) risks and the related responsibility to bring about a step change. Risks are easier to justify when greater pressures exist and this is admittedly not currently the case in the UK – although global water pressures – much like climate change - will directly affect the UK and engaging in global solutions will inevitably reap rewards.

- ◆ 3: Water – energy nexus: Electricity suppliers as major water consumers and water companies as major electricity consumers, water companies as electricity producers.

Water – energy nexus: global water pressures have in many cases resulted in significant energy demands. Seawater desalination is a prime example and water recycling is an attempt to alleviate this problem (the salinity of seawater vs wastewater is 35 g/L vs 1 g/L with direct impact on energy savings). A relevant public consultation by Scottish Government on Scottish Water has recently closed (see Hydro Nation). Discussions focused on the following main themes;

1) Energy efficiency of water treatment operations: more efficient technologies (see also Q1), energy neutral treatment, energy benchmarking to set aspirational targets, maximize treatment at low energy demand times (storage of water vs energy), utility integration, energy balance over the water cycle (recovery/generation opportunities), water pinch: multiple use of water before re-treatment, low energy aeration, process optimization,

2) Energy generation by water companies: direct installation of renewable energy on land/buildings of water companies, electricity generation at the point of consumption (reducing inefficiencies in electricity transport), centralized vs decentralized opportunities, cost-benefit analysis of direct power generation, planning permission, building regulations, environmental regulation in construction phase, water companies as net exporters of energy, energy from water pressure/distribution mains, chlorine/hydrogen plants, biogas, wind farms, fuel cells, forward osmosis.

3) Exploring the energy-water company interface: use of waste heat from power plants in water treatment, recycled water for power plants (instead of sea/surface water; boiler cooling), can electricity companies assist in water innovation, should water companies run water operations of power plants and vice versa, joint savings through water-energy-company collaboration, electricity cables in water mains, treatment processes for joint solutions.

4) Incentives: power companies appear to be ahead with metering/billing and hence have a degree of flexibility in investment, community schemes, ecotowns, Scottish Water Horizons as an example, holistic approach to carbon footprint.

5) Impact of electricity generation on water quality: wind farms affect catchment (during construction) and hydroelectric schemes result in ongoing water quality issues.

It appears that there is potential for stimulating discussions between the water and energy sectors from both regulatory and technical perspective to come up with innovative ideas.

Questions Set 2

- ◆ 4: In what areas can the UK secure the position of global leader in water technology innovation?

According to some groups, being a global leader in water innovation may not be an aspiration held by the UK players and a more comfortable role may be to follow policy direction. Others feel that innovation may be more appreciated outside the UK market and that the supply chain in fact needs to find other markets and later apply in the UK. A change to a less risk adverse approach, more innovation funding and visionary leaders are required to drive innovation forward. Culture, funding, politics and technology needs interplay to enable or disable innovation. Responses covered different degrees of ambition although not all focused on advanced treatment technologies;

- 1) Existing areas of UK leadership: skilled staff and technical expertise, project management, customer service (innovative ways to make customers happy), leakage/asset management, analytics, research/consultancy, material science (nanotech, chemistry, functionalized membranes), process optimization, risk based approach to water safety plans (catchment management), regulatory framework, desalination, knowledge transfer, managing aging infrastructure.
- 2) Leadership potential: some technologies and technical expertise (e.g. activated filtration media, low head hydro generation, information technology, real time process control, instrumentation and monitoring, smart nanotechnology and materials to usable applications, (bio)sensor development, off grid treatment solutions, environmental technology, membrane technologies, oxidation processes, LEDs, filter technologies, water saving devices,) and services (e.g. bespoke high quality water, small supplies (few m³/day), farm irrigation techniques, water footprint methodology, water-wastewater technology integration, integration of water and energy, application of current technologies, business planning, operation schemes, test-bed technologies and sell technology + approach.
- 3) Currently lacking leadership potential: manufacturing.

Questions were raised about Engineering and Physical Sciences Research Council (EPSRC) leading areas of research (how is the ongoing blue-sky research in the area communicated effectively) and the outcomes of the impact statements generated by researchers. The focus on impact is relatively new and EPSRC was not represented at the workshop to comment leaving this as an item for follow on events.

- ◆ 5: How can the supply chain be supported adequately to facilitate export of UK advanced water treatment technologies

The supply chain was well represented at this workshop and needs are well articulated. These can be summarised into four main categories;

- 1) Funding: loads of money often helps - while some schemes exist (e.g. Scottish Enterprise, TSB, UKWIR, WRc, Export guarantee scheme, Water UK) a UK wide scheme of tax credits, risk sharing with supply chain, portal to identify funding opportunities, establish contacts with venture capitalists, mechanism for technology transfer (e.g. green banks), funding for research rather than managing business, better access to EU funding, tax credits for SMEs instead of grants, UK government to support EU technology platforms,
- 2) Skills support: better understanding of market intelligence, better skills for UK Trade and Investment for exports, better development by supply chain to sell to UK water industry, cultural/public acceptance, identify export markets, market penetration through licensing/local agents/experts in local territories, insurance/liability support, identify and address global knowledge gaps and opportunities, frameworks to enable innovation; global recognition of DWI approval (gold standard), acceptance of EU wide approval (similar to healthcare), understanding country specific regulations and specifications, international patenting, risk sharing.
- 3) Build Playgrounds for water companies/suppliers/academia such as;
- high quality demonstration/flagship facilities (e.g. Mery-sur-Oise Nanofiltration, Barcelona electrodialysis, Advanced Water Recycling Demonstration Plant, Thames Water/Beckton Desalination Plant, NeWater Singapore);

- national demonstration/trial facilities for multiple technologies (e.g. Energy and Environmental Research Center (EERC) in Grand Forks, North Dakota, USA; Walkerton Clean Water Centre Announces Technology Demonstration Facility, Canada) can stimulate research, technology adaptation and technology transfer through the pilot phase and provide essential facilities that are too costly for SMEs to establish and operate
- use UK Water company reference sites and trial sites for proving technologies at home in return for cut of overseas sales
- independent test beds to accelerate pilot innovations; local proof of concept facilities; UK wide proving centre
- water companies acting as ambassadors for new UK technology through piloting, early adoption and approving

- 4) Partnerships: bridging the perceived gap between university projects and delivery of reliable technology to/by companies, joint ventures between water companies and suppliers (e.g. Germany), cooperation between supply chain and internationally active consultants, local enterprise partnerships

In summary, the difficulties experienced by SMEs/supply chain in having technology tested and approved within the UK, lack of enthusiastic responses from the water industry to trial novel technologies and difficulties in reaching requirements for export is immediately visible. National strategies and facilities to overcome some of the common obstacles and enable the sector to succeed appear to promise great return to the UK economy and stimulate innovation in the broader UK water sector.

◆ 6: Can water markets of water stressed regions become pilot sites for future UK needs?

The context of the question was that water stress is an emerging problem in the UK restricted currently only to the South-East. While climate change and increasing consumption may increase such pressure, there is no immediate need (and hence market) to respond. In consequence industry sees little drive to develop suitable technologies unless those can be deployed to water stressed region in the meantime. Answers fall into three main categories;

- 1) Learning from the overseas experience: what technologies can we adopt from water stressed regions?, willingness to pay from water stressed customers, product labeling, consumer awareness, education, energy ratings: adopt to water (see appliances, voluntary industry scheme), different attitudes to water, irrigation experience, what has not worked in countries with a 'burning platform', learn from successes & failures.
- 2) Knowledge of what future UK needs will be: only extreme events will make the UK truly water-stressed, which climate change model should the UK adopt?, severe contamination as inward investment opportunity.
- 3) Opportunity to demonstrate innovation elsewhere: barriers to be overcome, moral concern over 'tied aid', if we are not prepared to invest now will we be prepared to in the future?, technology demonstration and data gathering as a proof of concept elsewhere, specific local circumstances and market acceptance need considering, refine designs, opportunity for blank sheet solutions rather than retrofitting, UK more likely to adopt technology that is proven elsewhere?, reuse concepts/applies technology, show that a new technology will not kill people elsewhere makes it easier to sell in UK, only for specific technical challenges, nano-membranes for developing countries, crop irrigation, reuse concepts, life cycle techniques.

Overall, it is difficult to imagine why in a century of globalization one would distinguish between UK and overseas markets. Global players are ultimately targeting an international market to maximize returns and develop state-of-the-art technologies. Are we too UK-centric in our approach as compared to our international colleagues? Inevitably UK responses to global problems will stimulate our local industry and contribute to job creation which appears a sensible strategy, especially in times of widespread economic difficulties.

Questions Set 3

- 7: What role does the UK water industry play in fostering innovation? What can we learn from the energy sector?

The Role of the water industry in fostering innovation: clearly the industry is perceived to do not as much as it could. A number of themes emerged from discussion;

- 1) Academia-Industry partnerships: Historically academics approach industry with little desire for two directional partnership from industry, support is predominantly in-kind to the higher education sector with some student sponsorship. Better expertise in water companies is required to support development and introduction of new technologies. Successes need to be better advertised. Support to test and assess new technology more effectively.
- 2) Innovation approaches: The industry is seen as 'fast followers', with a preference to tried and tested technology. Longer term regulatory periods combined with set aspirations and directions are needed. Identify sticks and carrots (an approach that non-leaders appear to need for performance) to achieve carbon reduction/reduced energy consumption, etc.. The utilities have needs and 'purchase' innovative products/services to meet their targets. The supply chain needs to work with utilities to deliver appropriate products, an industrial liaison network in industry to bring start-ups to industry – and demo sites for practitioners are a strong need. Water services are seen as a 'silo' that inhibits a holistic approach to water/energy/food/resources.
- 3) A fragmented industry: A central pot of money dedicated to innovation is missing in the water sector and the organization of innovation stakeholders is fragmented between OFWAT, British Water, Water UK, Water TAG, Innovation & Leadership Group, UKWIR and ESKTN. WRc is seen to conduct umbrella research while UKWIR funds industry relevant research projects. Mouchel Technology Approval Group (TAG) was presented as a nice example to defend ideas in front of industry for support/attract investors. Industry bodies such as UKWIR promote collaboration.

Although few of us have little knowledge of how the energy sector operates, the workshop audience included a number of energy experts. The water industry may benefit from some ideas and best practice in the energy sector. So what can we learn from the energy sector?

- 1) The energy sector enjoys a stronger competition and freedom in setting of tariffs, technologies. Innovation is driven by price and resource while there is a perception of stronger research & innovation funding. Innovation in products and processes. Money available to invest. OFGEM Innovation fund: drives research and development of new technologies but question the value for money for customers in the short term. Potentially this is beneficial as it focuses on long term benefit rather than short term gains. Are there better ways?
- 2) Strong metering (incl. SMART meters), promotion of efficient energy generation, tariff control
- 3) Coordination of research and innovation with academics and industry (e.g. Energy Technology Partnership). Suppliers as major innovation drivers in the energy sector. Willingness to do and fund demos (e.g. Carbon Capture and Storage (CCS)), Energy sector has partnerships and mechanisms for trialing new tech in a 'safe' environment – no such facility exists for water/wastewater – relies on ad-hoc project-specific agreements to use live plant or redundant capacity. There is a community of R&D/Innovation professionals who largely know and trust each other who can come together to pool resource to undertake collaborative research.
- 4) Networks and communication, active networks, national supply system, grids (versus canals), feed-in tariffs from alternate sources (e.g. renewable energy)
- 5) Communication of future priorities and longer term 'road maps' with stewardship considerations. Critical drivers being oil & gas, climate change and historical image. National Renewables Infrastructure Plan (N-RIP).
- 6) Mandatory supplier obligations and reduction commitments (same for water companies?), a more standardized industry and customer incentives (e.g. energy saving policies and activities, consumption based energy bills, customers have choice over supplier).

Inevitably the water and energy sectors are distinctly different, it is difficult to see why energy should be metered and billed while water is an unlimited consumption commodity. Partnerships and innovation can no doubt adapt similar models while regulation takes account of the distinct differences such as water quality.

♣ 8: How can UK policy enable more innovation?

Government and the water industry are in a grid lock situation where one is pointing the finger at the other to take responsibility for driving a step change in innovation. While DEFRA states, somewhat tongue-in-cheek, 'not with (our) money!' it may not take money to create some innovation instilling policies. Current policy attempts to drive innovation through standard setting where processes chosen to attain standards are not prescribed. Constraints and opportunities can be summarized as;

- 1) Policy: Financial regulation however is seen to stifle innovation as low risk solutions are rewarded; 5 yr AMP/Q&S cycles perceived as constraint with a need to develop/agree longer term investments, can we look at another industry/countries for more innovation enabling policy (e.g. medical devices), more transparent tax credits, full metering and charging for usage, consider full water cycle rather than drinking water?, capital efficiencies should generate savings for >5yrs, remove silos in policy making: holistic and innovative thinking, need for policy makers to be better informed (work with academia?), mandatory/legislative targets on industry to drive innovation, regulatory duties on all parties, innovation levy on water bills to fund Technology Innovation Centre for Water, consider other funding structures (e.g. Finland), risk-based regulation (enabling outcome driven activity over prescriptive intervention), financial incentives and simplified regulation, regulatory acceptance of risk in demonstration, allow regulatory space for companies to try innovative techniques.
- 2) Research investment: currently perceived as inefficient expenditure, is a change in research & development structure required to provide incentives?, less aversion to risk, funding allocation and flexibility (e.g. SCAMP allows deferral of capex), setting aspirational achievable targets, access of small business to academic research facilities (HE full economic costing may stifle this).
- 3) Research to product cycles: reduce barriers in approval procedures, 5yr AMP periods limit innovation: results in 'comfort zone' known solutions under tight deadlines, 12 years from research to product, alternative industry structure: biased towards capital expenditure, extend R&D tax credits to water company investment in SME research, letting failure happen: remove stigma and other constraints around SME collapse, adequate funding for SMEs (large & small projects), risk/finance shared with all parties involved (SMEs, utilities, innovators, etc), research council funds should go to SMEs (?), flexibility in standards/consents – allow piloting, improve finance of R&D schemes into practical applications.
- 4) Political leadership: informing political leaders, proactive involvement in EU policy and standards, UK wide policy for economies of scale rather than (England & Wales, Scotland, Northern Ireland split), big political wins not always good value for money, joined up infrastructure/agencies (Christie Commission into Public Services into action).
- 5) Science & Technology education: facilitate knowledge exchange, state of the art sharing to increase rate of adoption, ensure follow through from research to commercialization, change peer review for engineering committees in research councils removing 'novelty' with 'utility', fund a Technology and Innovation Centre dedicated to water, support S&T education and link with business education.
- 6) Public education: public can drive willingness to act.

The role of economic regulation in hindering innovation is not new and this was a recurring theme during the workshop. Solutions to this issue may well be found in the energy sector while it appears difficult to make substantial progress while water is not metered and the public unaware of the efforts required to source, treat, deliver and re-treat our water. A positive approach would be well informed political leadership to address and foresee challenges in partnership with the industry and the public appears.

◆ 9: How can UK research talent be encouraged to work together and provide leadership in innovation generation?

The UK (academic) talent in advanced water treatment technology is dispersed in civil engineering where traditionally water research was hosted, chemical engineering that has comparatively little interest in water treatment and an increasing activity in chemistry/materials science applicable to water treatment. Scatter is huge which does not assist collaboration and international visibility of the UK talent base as a whole. A number of avenues resulted from group discussion;

- 1) Defining research problems: policy makers and industry should have a role – Einstein's 55 minutes to define the problem, define problems to be solved well, raising awareness of problems to be solved to engage researchers.
- 2) Identification of research capability: identify strengths, co-ordination of UK research – STREAM type approach
- 3) Spirit of collaboration: complementing rather than competing between research projects at universities, collaboration between universities generally good, but missing links with industry, between policy/academia/industry partnerships, tension in intellectual property rights versus collaboration benefits, multidisciplinary approach in research structure
- 4) Knowledge sharing: UKWIR funding for knowledge sharing, not just academic driving innovation, stimulating knowledge networks to small businesses, scientists, engineers & commercial sectors need to work together, knowledge transfer partnerships, placements/interns/undergraduate training, knowledge transfer not part of the day job, senior leadership/KT departments in Universities can undermine commercialization, new HE landscape may deliver unintended outcomes, EEN-type 'Offer-Need exchange' (ESKTN?), personnel secondments/placements into supply chain and utilities, KTPs more affordable to SMEs, water company involvement in delivery.
- 5) Funding: Adequate funding, industry-university funded schemes, support of interdisciplinary research, academic rewards are for research, are universities best placed for development?, bring back industrial case awards, Talent Scotland needs better marketing, well funded calls for carefully defined outcomes that encourage collaborative submissions (Sandpits), water innovation platform funding,
- 6) Centre for excellence in water: one stop shop (in Scotland or UK wide?), themed industry lead Grand Challenges – funded from Funding Councils and Sector Fund, initiate an open 'UK Water Innovation Conference/Forum' specifically to discuss regularly new ideas, research, opportunities, etc.
- 7) Intelligent customer: awareness of emerging technologies/research in independent manner, embedding the right culture, focus on customer needs and affordability, education can create a pull,

UK research talent does not always do each other favours. A funding depleted sector has resulted in fierce competition which has further decreased funding and sometimes credibility. For example, KTN roadmaps for research priorities often reflect unbalanced academic participation (pushing their own agenda) more than actual research needs. Peer review in the water sector is sometimes focused on giving perceived competitors overly critical reviews reducing funding allocated to the sector while other sectors outcompete water with success by supporting colleagues with maybe overly positive reviews. A change in collaborative culture and attitude will most likely result in a thriving sector that lobbies for the common cause together. Equally, a more streamlined approach of developing research priorities in an objective and inclusive manner and dedicated funding calls will create better impact.

Questions Set 4

- ◆ 10: What funding models will be most beneficial to facilitate invention, proof of concept and technology transfer in a high risk/high gain industry?

A valid question asked by the participants: is our industry a high risk/high gain industry? It isn't. But the advanced water treatment industry – the focus area of the workshop – is a high risk industry because SMEs in this area require access to a lot of manufacturing and testing infrastructure that requires a high upfront capital investment. The global water market is immense reflecting potential high gain (this is reflected in the growth of the membrane industry, predominantly outside the UK, in recent decades). In that light, available funding initiatives for SMEs are often insignificant in this area. Workshop participants have come up with a number of funding models;

- 1) Funding Model examples:
 - EUREKA programme model – works well in rest of Europe (just a shame that the UK subscribes to it via the TSB but does not provide the funding as other countries do...)
 - SMART style funding for riskier early stage R&D, Proof of Concept (Scottish Enterprise)
 - Dedicated Water Innovation Fund (see Cave/CST Reports)
 - Fraction of water bill ring fenced for R&D funding, centrally funded from levy/tax on bills or company profits
 - Enterprise Investor Scheme worked – founders and investors
 - TSB Innovation Platform
 - TAG group (Pierce Clark): combining small companies exposure to utilities investor funding
- 2) Funding schemes: not just the available funding but how it is spent (doubling of fees and additional consultancy layers, high administration), do not reflect practicalities of 'research processes' – dumbing down and loss of innovation, experts to fill the forms, politicians/civil servants do not understand the technology, need for incentives, incentive mechanisms need to recognize long term nature of R&D/innovation to adoption, copious options not well understood, Tiers – Government (strategic), Regulators (operational), Water companies, UK Research Council, Suppliers, greater funding commitment from industry, ideal model: water companies provides a supplier with £ for specific R&R but this isn't possible, are funding models long term enough?, challenges in testing new products given variation in our raw material (water), collaborative-open innovation funding model, loss of regional development Agencies and move to TSB lost touch with local SMEs and requirements, does municipal vs private water company drive more innovation (see USA), French model of vertical integration (supplier & municipal operator) allows large R&D spend, development and commercial product – lack of competition (globally), focus on value for money concepts combined with innovative processes, innovation by SMEs/supply chain not championed by private sector, project delivery partnership approaches, regulatory regime able to accommodate risk, tendering: constraints if only one provider slows implementation/use/innovation, Water Innovation Park (Research Council Funding involved), bank borrowing difficult for innovation/private equity used, bank finance more available for established businesses/processes: needs an option to the interim as well as research council funding, finance provision by new players (e.g. power industry/non household side in Scotland) to drive innovation, better mechanisms for consultancies to work more with research & suppliers would help.
- 3) De-Risking: Risk/finance & benefit sharing, de-risking investments through thorough technical due-diligence, structured stage gate approach, shared risk funding, protection of IP an important issue, tried and tested processes: but who covers costs for testing?, how to generate financial return within short timeframes?, use sustainability as well as water quality goals (German model), design-build-own and operate model does not always drive innovation: get model right.
- 4) Risk-taking: Venture capital: where is an acceptance of the Venture – element?, acceptance of new technology by regulator/water companies, high gain will drive innovation, dare to change full process chain rather than tagging on bandage after bandage for compliance.
- 5) Water value: no reward potential if water is continued to be sold for pennies, remove geographical averaging of charges, incorporate energy costs, capital efficiencies should generate savings for > 5 years, allow longer pay-back periods (12yr research to product, see longer French operational contract periods).

It appears that strategies of creative funding models of a more sustainable duration, adequate rewards for taking controlled risks and a better appreciation of the value of water, in particular the value of the water produced using advanced water treatment processes would be a significant step forward.

- ◆ 11: How to support spin off, capital investment and business strategy in the gap between proof of concept and full roll out?

A step on from Q10 now the concern is specifically about how to get good and proven ideas to market, addressing the gap between technology development and market adoption.

1) Funding models: SMART funding Phase II, 5yr industry periods unhelpful, markets, industry, accept risk of failure, first ten years of corporation tax on dividends only – timing hits at time when needed for investment, VC looking at MB not start-ups, investment funds managed by VCs with public money should not have preferential exit clauses, WaterTAG –type approach, third party due diligence for investors as signals for potential funders, early stage commitment to buy by water companies ('forward-commitment procurement' approach), Championing of concepts and technologies, 95% spin out companies close down mainly because of short term return required by VCs, demonstration budgets, major innovation prizes, research councils to support more applied research, universities need to link up with relatively early stage companies: research council or development agency support, export markets outside the water sector (e.g. industry), use money used for legal contractual commitments to fund innovation (%levy?), levy/land tax approach, see OFGEM innovation fund and scheme proposals, financial incentives for innovation (benefits not always transferred to customers), where would levy go – would need to be different from current UKWIR research priorities.

2) National Demonstration sites: test bed demonstration facilities, regional facilities for technology testing: north/south divide, national demonstration centres – single national body – shared results – rapid testing of technology, bridge gap between academia / proof of concept and pilot scale, collaborative trials – group investments from water companies, access to operators, live assets, etc., water specific incubation centres.

3) Business incubation, consumer awareness, improved advertising, exhibitions, workshops, conferences, framework for new business to meet investors and collaborators, business infrastructure to allow focus on technology development, involve water companies/supply chain in licensing, visibility of the short/medium term objective and long term objectives for industry, raise technical leadership: academics financial targets and industry engagement, do business leaders come out of universities?, transition of scientists/engineers to business?

A lot remains to be done from showcasing technology successes, testing facilities to proof technology performance and enabling funding models that assist innovators in the traverse of 'death valley'. The investment required to translate bright ideas into functional products is immense. Proof of concept stage has overcome key technical difficulties and it appears wasteful to see great product that may on occasion be ahead of their time fail. High visibility test facilities and technology competitions may be a helpful way to generate visibility and expose such innovations to a global investment market.

- ◆ 12: What are the skill requirements of our future water technology leaders?

The biggest contribution higher education can provide to the water sector is graduates with the right skills. A resources stretched sector cannot always deliver this adequately and funding cuts have placed strain on skills provision. For example many engineering curriculae no longer contain very important laboratory training (e.g. water quality testing or water treatment) let alone piloting experience. This put the quality of the solid engineering foundation in question and lacking depth will hinder innovation and confidence in graduates trying new technologies. Workshop participants have come up with a comprehensive list of desired skills;

1) Science & Engineering skills: process & bioprocess engineering skill set, systems engineering (water/energy/waste), chemists, chemical engineers and not just civils (or at least civils with a knowledge of chemistry), improved practical experience for university graduates during studies, structure required for innovating youth to be developed/educated by the more experienced (knowledge transfer) [industrial mentoring scheme?], practical knowledge of the industry, holistic view: end of pipe is not always the answer, breath of technology awareness to prevent technology lock-in.

- 2) Business skills: - 'Green economy skills' including knowledge of resource efficiency, environmental/financial accounting, marketing skills for scientists/technology leaders, right balance of technical-commercial expertise, commercial awareness, entrepreneurship, financial awareness.
- 3) People skills: Communication skills for scientists/technology leaders, improved communication and relationships with public and media, attitudes to promote a better image for the industry - bad publicity is largely the only publicity that makes the news, educators, influencers and communicators, political astuteness, political awareness.
- 4) Integrative skills: flexibility, leadership and clear vision, accept failure as an option and celebrate success, interdisciplinary understanding/approach, greater multi-disciplinarity, visionary, global view, holistic planning, sustainable living professionals, risk taking – piloting, 'big picture' cross sectoral capability, receptive to global best practice and desire not to reinvent the wheel, assessment of risk appetite and appropriate tolerance of uncertainty, willingness to give things a try, empowerment of individuals to suggest new ways of working.
- 5) Industry education: improved continuing education, addressing knowledge/experience gap (in operations), ensure Boards have broad base of skill – but in particular technical capability
- 6) Fluent Mandarin speaker.

No doubt this selection will keep academics on their feet and maybe rethink what our current degree offerings can really contribute. Clearly, Innovative education providers and other stakeholders need to work together to ascertain skill provision and much can be adapted from countries such as France and Germany where collaboration in training is highly valued and industry placements seen as a valuable recruitment strategy. It is important to remember that technical leaders require a solid technical foundation. Not all engineering graduates may have the ambition or capability to progress to managerial or business roles. Double degrees in business (e.g. an MBA/DBA) or tailored leadership training for those who do may be a far better approach than overly diluted engineering degrees. Exposure of candidates to a variety of industries and business roles during their degrees and holidays is a valuable tool for candidates to get clear on their career interests and abilities. School/university exchanges with China will certainly not be a bad strategy for ambitious future leaders.

UK Innovation Potential in Advanced Water Treatment: Future Directions & Strategy

Participatory Workshop Program – Thursday 30th June, 2011

James Clerk Maxwell Building (JCMB), Teaching Studio 3217

King's Buildings, Edinburgh University

| | | | |
|------------------|---|--|-------------------------|
| 9.00 a.m. | Welcome & Introduction of speakers, attendees and agenda | | |
| 9.10 a.m. | Innovation in the Water Sector? Dr Mike Walker | | DEFRA |
| 9.20 a.m. | The Regulator's Role in Innovation Matthew Bower | | DWQR |
| 9.40 a.m. | Water Innovation: Leadership Opportunities in the Water Industry George Ponton | | Scottish Water & UKWIR |
| 10.00 a.m. | Water Innovation Hub Dr Jim Marshall | | Water UK |
| 10.20 a.m. | Water Innovation from the Academic Perspective Prof Andrea Schäfer | | University of Edinburgh |
| 10.40–11.20a.m. | Morning Tea Visit to Laboratory for interested Participants | | |
| 11.30–12.15 a.m. | Questions Set 1 | Provision of prioritised outcomes to organising team | Group 1 & 5 |
| | Questions Set 2 | | Group 2 & 6 |
| | Questions Set 3 | | Group 3 & 7 |
| | Questions Set 4 | | Group 4 & 8 |
| 12.15-13.00 a.m. | Questions Set 2 | Provision of prioritised outcomes to organising team | Group 1 & 5 |
| | Questions Set 3 | | Group 2 & 6 |
| | Questions Set 4 | | Group 3 & 7 |
| | Questions Set 1 | | Group 4 & 8 |
| 1.00–2.00 pm | LUNCH – The Magnet Café | | |
| 2.00-2.45 p.m. | Questions Set 3 | Provision of prioritised outcomes to organising team | Group 1 & 5 |
| | Questions Set 4 | | Group 2 & 6 |
| | Questions Set 1 | | Group 3 & 7 |
| | Questions Set 2 | | Group 4 & 8 |
| 2.45-3.30 p.m. | Questions Set 4 | Provision of prioritised outcomes to organising team | Group 1 & 5 |
| | Questions Set 1 | | Group 2 & 6 |
| | Questions Set 2 | | Group 3 & 7 |
| | Questions Set 3 | | Group 4 & 8 |
| 3.30-4.00 p.m. | Afternoon Tea | | |
| 4.00 p.m. | Summary Discussion Question Set1 Chair: George Ponton | | |
| 4.20 p.m. | Summary Discussion Question Set 2 Chair: Mike Walker | | |
| 4.40 p.m. | Summary Discussion Question Set 3 Chair: Matthew Bower | | |
| 5.00 p.m. | Summary Discussion Question Set 4 Chair: Jim Marshall | | |
| 5.20-6.00 | DISCUSSION: Where to from here: An Action Plan for Water Innovation | | All |
| 6.00 | CLOSE | | |

Questions Set 1

- ◆ 1: State of the art in advanced water treatment technologies: What is the next generation of water treatment technology? Where are the innovation opportunities for the UK?
- ◆ 2: How to manage the disconnect between increasing water quality standards (in particular micropollutants) and requirement to reduce carbon emissions?
- ◆ 3: Water – energy nexus: Electricity suppliers as major water consumers and water companies as major electricity consumers, water companies as electricity producers.

Questions Set 2

- ◆ 4: In what areas can the UK secure the position of global leader in water technology innovation?
- ◆ 5: How can the supply chain be supported adequately to facilitate export of UK advanced water treatment technologies
- ◆ 6: Can water markets of water stressed regions become pilot sites for future UK needs?

Questions Set 3

- ◆ 7: What role does the UK water industry play in fostering innovation? What can we learn from the energy sector?
- ◆ 8: How can UK policy enable more innovation?
- ◆ 9: How can UK research talent be encouraged to work together and provide leadership in innovation generation?

Questions Set 4

- ◆ 10: What funding models will be most beneficial to facilitate invention, proof of concept and technology transfer in a high risk/high gain industry?
- ◆ 11: How to support spin off, capital investment and business strategy in the gap between proof of concept and full roll out?
- ◆ 12: What are the skill requirements of our future water technology leaders?

Workshop Hosts

Mike Walker, Defra – Matthew Bower, DWQR - George Ponton, Scottish Water - UKWIR - Andrea Schäfer, University of Edinburgh

Workshop Sponsors

The Workshop is supported by the EPSRC Defra Policy Fellowship Scheme 2010-2011 and Refreshments kindly provided by Defra.

UK Innovation Potential in Advanced Water Treatment: Future Directions & Strategy

Participatory Workshop Participants – Thursday 30th June, 2011

James Clerk Maxwell Building (JCMB), Teaching Studio 3217

King's Buildings, Edinburgh University

Organising Committee: Dr Mike Walker, Defra – Matthew Bower, DWQR - George Ponton, Scottish Water & UKWIR - Andrea Schäfer, University of Edinburgh

| Group | Attendance | Registered Participant | Affiliation |
|--------------|-------------------|-----------------------------------|---|
| Group 1 | Y | Amanda Lake (Chair) | Jacobs |
| | Y | Ian Hotson | United Utilities |
| | Y | Dr Mike Walker | Defra |
| | Y | Calum Reid | DrydenAqua |
| | Y | Dr Neil Polwart | Albagaia |
| | Y | Dr Henriette Jensen | Sheffield University |
| | Y | Dr Helen Bridle | Edinburgh University |
| | Y | Phil Leeks | Sepa Water Policy |
| Group 2 | N | Prof Gianluca Li Puma | Loughborough University |
| | Y | Vaibhav Tyugi (Chair) | OFWAT |
| | Y | Dr Tom Hall | WRc |
| | N | Dr Nik Kapur | Leeds University |
| | Y | Kevin Ferguson | Scotmas Ltd |
| | Y | Kevin Prior | CookPrior Associates Ltd |
| | N | Paul Weir | Scottish Water |
| | Y | Thanh Hieu Ngo | Edinburgh University |
| | Y | Taner Yonar | Newcastle University |
| Group 3 | N | Dr Mark Fletcher | ARUP |
| | Y | James Wood (Chair) | ARUP |
| | Y | Matthew Bower | Drinking Water Quality Regulator Scotland (DWQR) |
| | Y | Graham Tyrie | Albagaia |
| | Y | Gillian Bavister | ENTEC |
| | N | Prof Simon Parsons | Cranfield University |
| | Y | Dr Mike Dempsey | Manchester Metropolitan University |
| | Y | Prof Robert Field | Oxford University |
| | N | Clair Wright | Scottish Enterprise |
| | | | |
| Group 4 | Y | Prof David Stuckey (Chair) | Imperial College |
| | Y | Kerry Thomas | Environmental KTN |
| | Y | Prof Bryce Richards | Heriot-Watt University |
| | Y | Dr Jim Marshall | Water UK Innovation Hub |
| | N | Andrew Mackenzie | ERS |
| | Y | Tom Asprey | ERS |
| | Y | Alan Merry | ITT-PCI |
| | Y | George Ponton | Scottish Water |
| | Y | David Healy | Giltech |
| Group 5 | Y | Diane Duncan (Chair) | Highlands and Islands |

| | | | |
|---------|----------|--------------------------------|--------------------------------|
| | | | Enterprise |
| | Y | Nicholas Thomson | Grontmij |
| | Y | Dr Howard Dryden | DrydenAqua |
| | N | Nicolas Holmes | Nicolas Homes |
| | Y | Clive Dyson | Clarizon |
| | Y | Philip Graves | Strathclyde University |
| | Y | Prof Paul Christensen | Newcastle University |
| | Y | Dr Davide Mattia | Bath University |
| Group 6 | Y | Arthur Thornton (Chair) | Atkins |
| | Y | Jonathan Abra | Environmental KTN |
| | Y | Dr Stephen Lambert | DWI |
| | N | Dr Martin Tillotson | Leeds University |
| | Y | Tom Johnston | NSA Ltd |
| | Y | Peter Ross | Scottish Water |
| | Y | Prof Russell Howe | Aberdeen University |
| | Y | Prof Andrea Schäfer | Edinburgh University |
| Group 7 | Y | Ian Bernard (Chair) | British Water |
| | N | Lex Crawford | Veolia |
| | N | Dr Nic Booker | Mott Macdonald |
| | N | Nigel Goodman | CH2MHILL |
| | Y | Douglas Johns | Scottish Water |
| | Y | Prof Jason Reese | Strathclyde University |
| | N | Prof Bill Sloan | Glasgow University |
| | Y | Prof Gerard Markx | Heriot-Watt University |
| | Y | Khalid Zakaria | Newcastle University (Visitor) |
| Group 8 | Y | Bernd Gantert (Chair) | Biotec International Ltd. |
| | Y | Iain Tait | Water Industry Commission |
| | N | Dr Gavin Collins | Glasgow University |
| | Y | Elise Cartmell | Cranfield University |
| | Y | Richard Gueterbock | Clearfleau |
| | Y | Alastair Muir | Halcrow |
| | Y | Dr Spela Ivekovic | Strathclyde University |
| | N | Dawn Stewart | Giltech |
| | Y | Payam Malek | Edinburgh University |

Innovation in the Water Sector ?

(an English perspective..)

Mike Walker

UK Innovations Potential in Advanced Water Treatment : future directions and strategy

University of Edinburgh, 30 June 2011

Drivers for innovation

- CEMEP
 - recommended a review of Ofwat's duties to give greater prominence to the importance of environmental innovation in meeting sustainability
- Lord Sainsbury - similar recommendation in 'The Race to the Top'
- Council for Science and Technology reported too little innovation in water industry

Drivers for Innovation (2)

- Cave recommendations to improve the innovative capacity of the industry. Eg
 - water stakeholders should come together to form a national water R&D body;
 - the creation of a £20million R&D fund; and
 - placing a duty on Ofwat to promote innovation.

The Challenge: Climate Change

- Changes to seasonal availability of water changes
 - Wetter winters and drier, hotter summers
 - Less water for supply and biota in summer
 - Less water to dilute effluent
 - More intense winter rainfall – how to utilise?

The Challenge: Water Quality

Real improvements in water quality

But under wider WFD assessment , risks of failing to meet good status :

| | |
|----------------|----|
| Rivers | 93 |
| Lakes | 84 |
| Estuaries | 99 |
| Coastal waters | 85 |
| Ground water | 75 |



Tightening standards – eg Priority Substances
And what about the future – under a changed climate ?

Carbon and water

More water = more carbon emissions

- Supplying water and treating sewage produces 5 million tonnes of greenhouse gas emissions per year
- **< 1% of emissions**
- Domestic hot water use produces about 35 million tonnes of greenhouse gases (CO₂e) per year
- **5% of emissions**



Pictures courtesy of Waterwise

The Challenge of Carbon....



- Emissions targets (80% GHG reduction on 1990 baseline, by 2050)
 - Versus increased emissions from
- Increased emissions (4x ?) from anticipated raising of treatment standards for drinking and waste water; projected increases in demand; etc

Innovation – moving forward (1)



- Innovation Leadership Group
 - Defra, Ofwat, DWI, Environment Agency, Water UK
 - Priority areas for innovation published in May
 - Look to sector to take forward
 - eg WaterUK's Innovation Hub

ILG priorities



- | | |
|---|--|
| • Leakage | • Promote end user education – reducing water consumption and promoting sustainable disposal |
| • Adapting infrastructure to climate change | • Reducing water supply interruptions |
| • Economic regulatory reform to incentivise markets and innovation | • Comprehensive underground asset mapping |
| • Environmental pollution prevention | • Smart metering |
| • Sustainable drainage | • Sustainable abstraction |
| • Increasing efficiencies in treatment processes and waste management | |

Innovation – moving forward (2)



- Technology Strategy Board
 - Case not made for full Innovation Platform in the water industry – can't make money for UK plc
- But TSB & Defra will
- Launch a 'challenge' to the supply chain to test innovation capacity
 - Challenge to address overseas issues that will hit UK in future

Innovation – moving forward (3)



- UK Water Research & Innovation Forum
 - Sir John Beddington initiative
 - LWEC developing a strategy

Europe



- Possible European Innovation Platform
 - Focus on 'water efficiency'
 - DG ENV hosting meeting for MS next week

The Drinking Water Quality Regulator for Scotland

UK Water Innovation Workshop

The Regulator's Role in Innovation

Matt Bower



What do we do?

- Audit and Inspection
- Incident Investigation
- Enforcement
- Consumer Issues
- Provide Information
- Investment
- Policy / Regulation Development
- Research
- Oversee Private Water Supplies



What is a Water Quality Regulator For?

- **Protect Public Health**



What is a Water Quality Regulator For?

- **Protect Public Health**
- Ensure Compliance with Regulations
- Maintain Confidence in the Water Supply
- Independent Source of Information
- Support and Advise Ministers
- Promote Robust Science Within Water Industry



Why do we need Innovation?

To Drive Improvement



Why do we need Innovation?

To Drive Improvement



Why do we need Innovation?

To Understand & Address Changing Consumer Expectations



dwqr

Why do we need Innovation?

To Understand & Address Changing Consumer Expectations



dwqr

Why do we need Innovation?

To Meet Particular Challenges

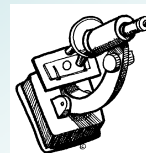


dwqr

Why do we need Innovation?

Improve Understanding

- Of Risks
- Of Water Science



dwqr

Why do we need Innovation?

Business / Aid Opportunities



dwqr

Why do we need Innovation?

Enhance Industry Skills & Expertise



dwqr

Does the Regulatory Regime Inhibit Innovation?



Does the Regulatory Regime Inhibit Innovation?

Probably.....



Does the Regulatory Regime Inhibit Innovation?

Probably.....

It's Partly Why We're Here!



Does the Regulatory Regime Inhibit Innovation?

- Regulatory Compliance
- Enforcement / Prosecution
- Codes of Practice / Guidance
- Product / Process Approvals



Does the Regulatory Regime Inhibit Innovation?



Approvals Process

- Reg. 27 Scotland / 31 England & Wales
- Cost
- Time
- Flexibility
- Necessary?
- How could it be improved?



Does the Regulatory Regime Inhibit Innovation?



Approvals Process

- Allows for Harmonised Standards (BS:EN, CE) but still need to be listed
- Reg.27(4)c
 - Can use substance / product for purposes of testing / research
 - 12 months unless varied
 - Due diligence



How Can the Regulator Promote Innovation?

- Research projects
 - » Commission
 - » Participate
 - » Support
 - » Avoid Conflicts of Interest
- Positive Approach
- Actively Encourage & Support Innovative Solutions
- Transparent Processes
 - » Work to improve / streamline
- Share Information
- Get Involved



How Can the Regulator Promote Innovation?

- Research projects
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 - » Avoid Conflicts of Interest
- Positive Approach
- Actively Encourage & Support Innovative Solutions
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- Share Information
- Get Involved

BUT....



Public Health is Paramount !

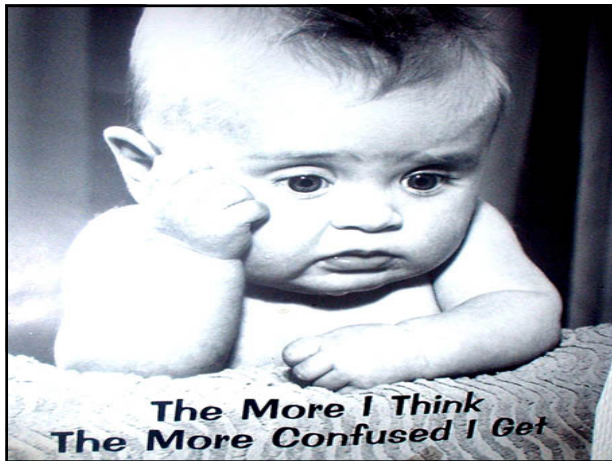


Water Innovation: Leadership Opportunities in the Water Industry

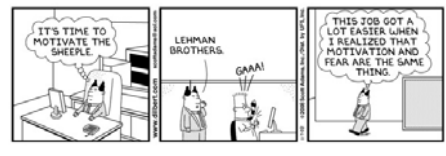
George Ponton
Head of Research and Innovation
george.ponton@scottishwater.co.uk



Who Are our Leaders?



What is Leadership?



What is Our Future?



We deliver valued, safe, trusted and reliable water in the most sustainable way

UKWIR Roadmaps



What Context?



Changing Supply Demand Balance



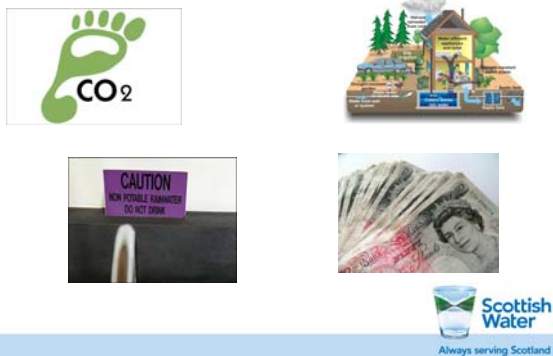
Changing Land Use



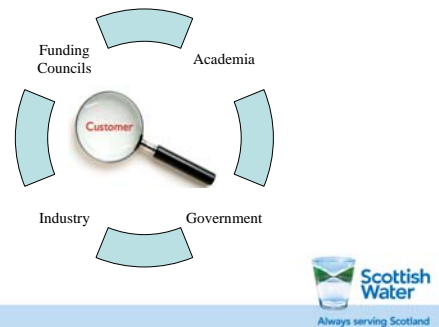
Challenges – Local & Global



Leadership Opportunities



So Who Should Lead?



The Final Leadership Challenge...



...making it believable!



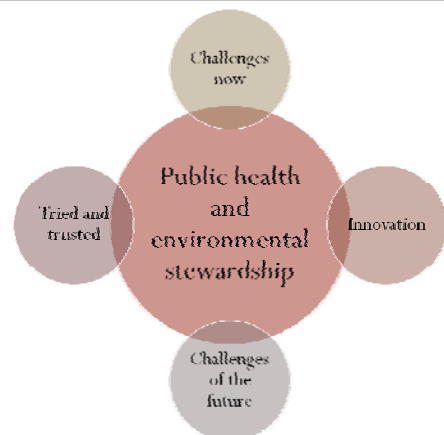
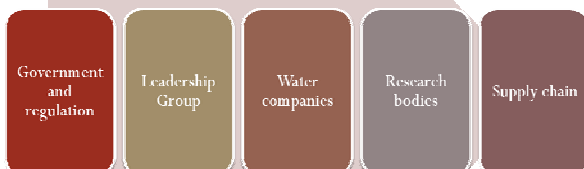
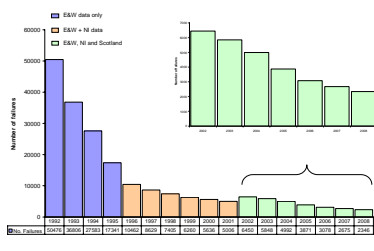
A strategy for an innovative water sector

Dr Jim Marshall
Policy and Business Advisor, Water UK

UK Innovation Potential in Advanced Water Treatment
Edinburgh, June 30 2011



An improving industry



JOIN THE REVOLUTION

UK Innovation Potential in Advanced Water Treatment:
Future Directions & Strategy
Participatory Workshop – Thursday 30th June, 2011

Water Innovation from the Academic Perspective

Andrea I. Schäfer

Chair of Environmental Engineering, Membrane Technology Research Group
www.see.ed.ac.uk/IIE/research/membrane
 School of Engineering, Institute for Infrastructure and Environment
 University of Edinburgh, United Kingdom

1

OUTLINE

1. What is Innovation?
2. Workshop Motivation
3. The Academic Perspective
4. Key Issues in Advanced Water Treatment
5. Innovation Examples
6. Questions?

2

WORKSHOP MOTIVATION

DEFRA-EPSC Policy Fellowship

- What is Policy and how is it made?
- How can Academia and Policy Makers work together better?
- How does the UK Water Industry and its Regulation function?
- What is Innovation in the UK Water Industry?
- Why is Innovation required when everything is working so well - Is it?
- What are the key Drivers for Innovation in Advanced Water Treatment?

3

INNOVATION?

'Innovation is the multi-stage process whereby organizations transform ideas into new/improved products, service or processes, in order to advance, compete and differentiate themselves successfully in their marketplace.'
 (Balghere *et al.* (2009))

'Invention: an idea made manifest - Innovation: ideas applied successfully in practice'
 'something new must be substantially different to be innovative'
 'goal of invention is positive change'
 'Innovation is the conversion of ideas into cash'
 'So as innovation typically changes value, innovation may also have a negative or destructive effect as new developments clear away or change old organizational forms and practices. Organizations that do not compensate effectively for innovative forces (mainly from outside) may be destroyed by those that do. Hence managing an organization typically involves risk. A key challenge in management is maintaining a balance between the current processes and business model.'
 'All innovation begins with creative ideas . . . We define innovation as the successful implementation of creative ideas within an organization.'

4
<http://en.wikipedia.org/wiki/Innovation> (accessed 11/2010)

WORKSHOP MOTIVATION

An Observation...

- Perceived Lack of Innovation in the Water Industry - A comfortable Water Industry?
- Cave Report (2009) – Regulatory Constraints?
- UKWIR Roadmap Strategic R&D Needs 2030
- Environmental KTN Report (2008)
- Council for Science and Technology Report (2009)
- Indepen Report (2011)

➡ - much blame on the regulatory system
 - absence of leadership in the water industry (waiting for government/policy incentives)
 - priorities are set by a select few and the wealth of knowledge available in the UK underutilised
 - underfunded sector (research councils)

5

WORKSHOP MOTIVATION

A workshop

- Bring together the non-traditionalists with potential to innovate in the advanced water treatment sector (Chemical vs Civil Engineering)
- What are the barriers to innovation dissemination (lab to market) and how to overcome those?
- Where are the niches where the UK can gain global leadership

➡ 12 Questions to reflect on today
 ➡ Action plan to proceed with a new collaborative initiative

6

ACADEMIC PERSPECTIVE

What do these Academics do all Day?

- **Research:** PhD Training, Publications, Research Projects/Grants: Global competition & knowledge generation
- **Teaching:** U/G & P/G Teaching, new MSc courses, needs of employers? Develop future leaders
- **Administrative:** University management, strategic initiatives & global consortia
- **Entrepreneurial:** Patents, Spin Offs, Consulting...

→

- how can one do all of this well?
- how can we increase efficiency in the sector?
- how can the best talent be adequately supported?
- how can the knowledge be best disseminated to the sector?

7

ACADEMIC PERSPECTIVE

How can Industry-Academia-Policy better interact?

- **Recognising what each sector can & cannot offer**
- **Resource Pooling** (e.g. joint facilities for technology testing or water characterisation?)
- **Funding Models** (e.g. Joint Research Council – Industry funding schemes? Better Output & Excellence link to funding)
- **New National Facilities** (e.g. Fraunhofer Institutes Germany)
- **New Training Models** (e.g. more industry/policy placements)
- **Reduce New Technology Fear: Bridging the Civ – Chem Eng/Chem Gap** (e.g. water process engineering discipline)
- **Water Technology Parks**
- **Fostering Diversity & Participation in the Sector**

8

KEY ISSUES

Drivers for Advanced Water Treatment Innovation

1. Water Quantity & Quality
2. Specific Energy Requirements (kWh/m³)
3. Micropollutant Fate & Removal

→

- How can we make water fit for specific purpose: no better and no worse?
- How can we make processes most energy efficient (Water is often biggest single user of a region)?
- Where can biggest improvements be achieved? (Water, wastewater, infrastructure...?)
- Water desalination versus water reuse
- Decentralised vs centralised systems (household, urine separation, etc): smarter approaches.

9

INNOVATION EXAMPLES

Membrane Technology Innovations (of the last decade)



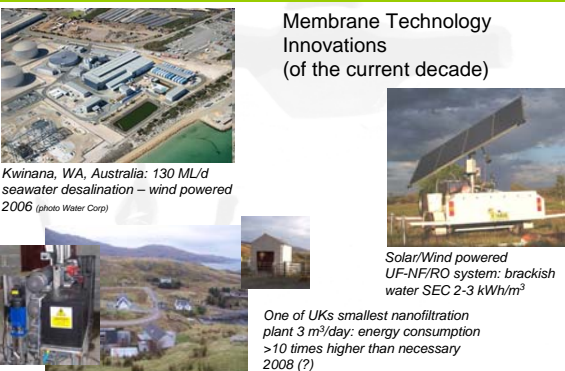
Small scale Microfiltration Homebush Bay (Sydney Olympic Park) 2000

Large scale NF Méry-sur-Oise (Paris) 1999

Advanced Water Recycling Demonstration Plant (QLD, Australia) 2000

INNOVATION EXAMPLES

Membrane Technology Innovations (of the current decade)



Kwinana, WA, Australia: 130 ML/d seawater desalination – wind powered 2006 (photo Water Corp)

Solar/Wind powered UF-NF/RO system: brackish water SEC 2-3 kWh/m³

One of UK's smallest nanofiltration plant 3 m³/day: energy consumption >10 times higher than necessary 2008 (?)

11


INNOVATIONS OUTLOOK

Where are the 'step changes' in water treatment going to be in the next decade?


- entirely novel materials (e.g. biomimetics or nanomaterials)
- entirely different process approaches (e.g. decentralised vs centralised; dual reticulation; smart technologies)
- water-energy nexus
- enabling approaches to entrepreneurship and industry creation in the water industry
- International development markets



12



INNOVATIONS OUTLOOK



'If I had an hour to solve a problem and my life depended on the solution, I would spend the first 55 minutes determining the proper question to ask, for once I know the proper question, I could solve the problem in less than five minutes.'


(Albert Einstein, 1879 – 1955, Physicist & Nobel Laureate)

'Happy are they that can hear their detractors and put them to mending.'


(William Shakespeare, 1564-1616, Much ado about nothing)

'We can't solve problems by using the same kind of thinking we used when we created them.' (Albert Einstein, 1879 – 1955, Physicist & Nobel Laureate)

13



QUESTIONS



Thank you for your attention.....

...?

UK Innovation Potential in Advanced Water Treatment: Future Directions & Strategy
Working Group Answers

Questions Set 1

1: State of the art in advanced water treatment technologies: What is the next generation of water treatment technology? Where are the innovation opportunities for the UK?

Group 1:

- Under-sink treatment! Micro-CHP
- Onsite CHP – e.g. for chemical dosing systems at WTW.
- Challenges: focus on wastewater? WTW – risk adverse, Reg26 cont. and adequate treatment barrier to new techno failures. Extensive periods of pilot trials requires. Disconnect btw pilot research/implementation due to risk aversion. Cost & 5 yr cycles (write off in spend on R&D of no benefit – but could this be a benefit elsewhere?). Remit of water companies, incentives to look outside of own area.
- Technologies: ozonation, UV (UU use EPA guidelines). Driver – risk averse. Technologies required in response to CC e.g. increased algal growth – but not necessarily ‘new technology’.
- Upstream ‘water treatment technologies’ – catchment mgmt (in collaboration for water companies). Challenge back on regulator (e.g NTU on boreholes)
- Nothing new but lower energy.
- Tightening standards forcing technology.

Group 2:

- Energy efficient, low chemical treatment
- Aim towards zero waste
- Simulation modeling of treatment process, training
- Efficient treatment processes by using sustainable materials
- Smarter materials e.g. membrane adsorbants
- Better understanding of risk on contaminants
- Reducing need for treatment

Group 3:

- question stifles innovation! What do we want from the next generation treatment. Spend 55 minutes defining the question
- short-term focus on what we do now but better, more sustainably
- changes in raw water characteristics due to climate change
- point of use treatment
- need to capture more information to inform debate
- advances in rainwater / greywater reuse

Group 4:

- anaerobic processes for recovering energy and reducing GHG & solids
- decentralized treatment & supply
- integration of solid waste in to sewage waste for digestion
- new adsorption and regeneration processes
- alternative treatments, photocatalytic,
- nanotechnology, in pipe treatment,
- utilization of waste from other industries as treatment
- control of processes, real time sensing of pathogens for better disinfection control
- mixing and cfd technology to better control

Group 5:

- low cost membranes – electro chemical ozone/UV
- cross disciplines - biological membranes/medical
- behavioural science – e.g. crypto infection risks understanding
- More effective detection systems
- point of use – intermediate technologies
- Point of generation
- Bilges on ships – cavitation – weakening of oocysts
- membrane bioreactor systems
- biological water treatment e.g. ammonia

Group 6:

- sensor technologies for long lead parameters (e.g. bacteria, crypto)

- decentralized sustainable off grid treatment solutions
- Environmental technology Solutions

Group 7:

- a) Starting with very small scale physical and chemical basics. (E.g Opportunities exist by utilizing nanotechnology) and how they affect systems performance. Historically, engineers and process engineers have worked at metre length scales and seconds.
- Low carbon and low energy technologies
- b) As the TSB has identified the innovation opportunities should be overseas. This is true if we have a strong UK demonstration market.

Group 8:

- Technologies need to be more sustainable and cheaper. Is the use of membranes to serve small communities appropriate? Need to develop more sustainable ways for water treatment. Sustainable catchments, lower water use in the home.
- Innovation seen always as high tech. Go back to extensive or older processes – e.g. stone media on filters as opposed to plastic media.
- Innovation can be regressive as well as progressive. Could free up Capex.
- Innovation opportunities – flood prevention (this could free up funding that could be used elsewhere) , catchment management, natural environment solutions, holistic management of the water cycle. Also holistic use of the resources – not just water as main product – use of landbank, hydro nation consultation try to create new opportunities and thus innovation.
- Smart sand, different medias, nano filtration membranes (carbon nano tubes)
- Advanced leakage detector technologies

🍷 **2: How to manage the disconnect between increasing water quality standards (in particular micropollutants) and requirement to reduce carbon emissions?**

Group 1:

- communication between regulator/industry on emerging issues, upcoming regulation. Even if awareness exists in industry – funding a problem.
- improved energy efficiency vs. use of renewables.
- lack of critical drivers?
- catchment management
- drivers for carbon reduction – regulatory, within Water Companies.
- financial/regulatory issues: write off of works for improved process versus bolt on solutions.
- skills within industry to quantify best whole life cost solutions from policy down/specs& standards up. Do we need to be better accountants... (£, environmental...carbon)
- carbon accounting is considered but capex still trumps?

Group 2:

- Better understanding and communicating risks
- Are the quality standards fit for purpose at current level? Waste & clean water

Group 3:

- rainwater / reuse reduces demand for high quality water
- remove pollutants at source – industry and farming
- efficient use of fertilizers / pesticides
- land management of catchments
- moving towards self-sufficiency for energy

Group 4:

- better understanding of risk of health & environmental effects of detectable substances
- overall assessment of the standards achievement v's environmental disbenefits
- source control – not reliance on end of pipe treatment – societal problem rather than water industry
- improved efficiency of existing technologies – better understanding and control
- differential standards of water for different uses

Group 5:

- Better detection
- lower energy membranes and biological processing
- point of pollution/ use treatment – especially rural areas?
- effective carbon market
- explore grey water reuse – reduce amount that needs treatment

- education
- optimum green fleet?
- private water supplies

Group 6:

- Control at source – catchment management, product use, product authorisation
- Risk-based assessment of impact on receiving environment
- Time-variant discharge consents
- Greater use of renewable energy. Generation of energy from waste (AD)
- Place the onus for replacement of lead pipes on householder (building regs)
- Treat less of it – separate systems, don't flush every time you pee

Group 7:

- The risk averse nature brought about by the regulatory regime discourages step change/risk taking with innovation.
- Management of the upstream catchment would and is helping water quality.

Group 8:

- Catchment management, source control, education, engagement with chemical industry and wider industries regarding new products including drugs, more sustainable treatment solutions including optimizing existing process.
 - Legislation to protect key water catchments – water companies become farmers? Or farming and water industry working together more. Incentives industry and farmers to utilize renewable energy technologies from waste which avoids their discharge.
 - Examine LCA or overall carbon cost of treatment solutions.
 - More research work to define actual environmental or health harm and real levels of treatment identified.
- Influencing EU policy in this area – risk based approached as favoured by UK also avoiding over precautionary principle.
- Come up with treatment solutions which are delivered by renewable energy.
 - Water recycling
 - Trapping rainwater / soil management / sponge
 - Increase use catchment rain water which hasn't picked up drug use etc from people.
 - Currently too expensive to separate urine with the high drug load. Work on reducing costs.
 - Not easy to treat surface water on site – work to improve this. Innovative water harvesting techniques. Aqueel product – cultivation tool to help water catchment.

3: Water – energy nexus: Electricity suppliers as major water consumers and water companies as major electricity consumers, water companies as electricity producers.

Group 1:

- Practicalities of hydro., considerations of scale. WC looking at wind, biogas. Impacts of large scale windfarms on catchment – planning permission considerations, environmental regulation – only construction phase.
- Impacts on water quality of hydroelectricity schemes – ongoing WQ issues.
- Cost benefits of water companies' own generation schemes.
- Electricity producers largely coastal/on large rivers (cooling water). Some use of final effluent by major energy users.
- Flooding & planning aspects of energy/water generation. Role of the planning process.
- centralized versus decentralized issue for energy generation vs water & wastewater treatment.
- Role of building regulations.

Group 2:

- Energy neutral waste water treatment plants
- Energy benchmarking to set aspirational targets

Group 3:

- Primary anaerobic digestion with CHP increases energy production
- increase treated water storage – maximize treatment at times of low energy demand, hence cheaper
- maximise renewable energy generation throughout infrastructure
- are electricity suppliers relevant to water innovation?
- power companies more advanced on billing – transfer opportunity
- Are electricity companies better placed to run water company power generation and water companies to run power treatment facilities?

Group 4:

- utility integration
- energy balance over the water cycle – what can we recover, generate
- water companies as net exporters of energy

- recycling of wastewater effluent for sources of water for other uses e.g. boiler cooling, etc.
- water pinch to get multiple use out of water before retreating

Group 5:

- Being addressed by SW following Hydro Nation
- Energy from water pressure
- ?chlorine/hydrogen plants
- exploration - biogas for transport
- wasted heat opportunities
- energy storage
- windfarm/peatland increasing impacts on water treatment costs

Group 6:

- Generation of energy from 'waste' – anaerobic digestion and biogas
- Solar and wind at point of use (obviously not solar in Scotland)
- Separate foul and surface sewer networks – minimize throughput at WWTWs
- Low energy aeration of wastewater
- Low pressure membranes
- Process optimization
- Recovery of kinetic energy from distribution mains via Pressure Reducing Valve-replacement

Group 7:

- Scottish Water Horizons is an example.
- Identifying and maximizing joint opportunities.
- Several wastewater opportunities
- Community schemes, ecotowns

Group 8:

- Need to include food as part of this.
- Joint savings available here. If water company or power company both get benefits – so get these companies together.
- Power company uses the dirty water, laying cables in water mains.
- Water company uses the low grade heat from the power company.
- Water company creating treatment processes which work to create joint solutions.
- Treat heavy industrial loads at source with water company contribution to funding. Energy generation for industrial user and reduces industrial discharge which might need to be treated aerobically.
- Holistic approach to carbon footprint will encourage this linkage.
- Potential regarding fuel cells. Use in sea water or wastewater – generates electricity without using clean/treated water.

Questions Set 2

4: In what areas can the UK secure the position of global leader in water technology innovation?

Group 1:

- Does UK need to secure such a position?! Water companies taking role of 'follower' – policy
- from supplier perspective: is innovation considered more valuable more out of the UK market?
- Does supply chain need to find market elsewhere for subsequent application in UK?
- At present none? But some specific technologies likely to be world leading ... AFM activated filtration media.

Group 2:

- Skilled staff, technical expertise
- Project management
- Customer services – innovative ways for happy customers ☺
- Leakage/Asset management

Group 3:

- low head hydro-generation
- information technology and real time process control
- Instrumentation and monitoring – real time results
- difficult to be global leader in manufacturing, focus on technical expertise
- bespoke high quality water
- small pop water supplies (few m³/day) – Scotland in particular
- smart nanotechnology and materials – development into usable applications

Group 4:

- sensor technologies for long lead parameters (e.g. bacteria, crypto)
- decentralized sustainable off grid treatment solutions
- Environmental technology Solutions

Group 5:

- where EPSRC leading areas of research? Impacts story still new...

Skills:

- Analytics
- membranes capability needs strengthened
- research/consultancy

Group 6:

- Materials science: nanotech, chemistry, functionalized membranes
- Process optimization
- Risk-based approach to water safety plans (catchment management)
- Regulatory framework (?)
- Desalination

Group 7:

- Without a change to less risk averse approach, more innovation funding and the visionary leaders it's difficult to say.
- Knowledge Transfer?
- Managing aging infrastructure
- You have to consider culture, funding, politics, etc as well as technology needs.

Group 8:

- Global leadership is perhaps not in current but in next generation of technologies. Also, application of current technologies – linking water to energy etc
- potential for flexible operation due to closer links to regulators – opportunity to 'test-bed' innovative technologies and then sell them along with approach.
- asset life cycle planning – linking water resources to treatment requirements etc, integrating business planning for companies across the water sector. Selling knowledge of how water and wastewater technologies can be integrated into a single strategic approach.
- opportunities to innovate in areas such as new water treatment processes in longer term – blue sky research is underway
- also opportunities to export technology on low head hydro, renewables in general
- innovation in filtration processes oxidation processes, LEDs, spruce filters
- potential market for water saving devices and techniques
- farm irrigation techniques developed here could be exported
- develop thinking on water footprint
- using industry knowledge for customer leakage detection
- Remote sensing for non-intrusive leakage detection for water distribution network

🍷 **5: How can the supply chain be supported adequately to facilitate export of UK advanced water treatment technologies**

Group 1:

- With funding, grants, sponsorship, advice. Do we need a recreation of UK wide proving centre/scheme? UK WIR, WRc exist...
- Driver for suppliers to export due to lack of support from rest of Water Industry?
- Relationships between suppliers/water companies evident in other countries (e.g. Germany) not present in Australia
- Less of a partnering relationship.
- In past water companies have bought companies & technologies... this wasn't necessarily fruitful, water companies have perhaps reduced such investments.
- Better development by supply chain in selling their technologies to UK industry.
- Existing business support exists e.g. Scottish Enterprise.
- Local enterprise partnerships – in development?
- through better working relationships between water companies/suppliers/academia. A playground.

Group 2:

- Independent test beds to accelerate pilot innovations
- Better understanding of market intelligence

- Risk sharing with supply chain

Group 3:

- high quality demonstration facilities, eg Mery sur Oise NF plant
- demonstration facilities for multiple technologies
- Water UK good, UK Trade and Investment
- Export guarantee scheme is good – Gov underwrites 80%(?) of value
- Understanding country specific regulation and specifications
- support with international / Community patenting
- Healthcare implants eg hip replacements – approval in one EU country is all that is needed – similar required for Water Industry

Group 4:

- trade missions with a water theme
- utilization of national trial site to gather data on new technologies
- UK water company reference sites
- Joint development of technology between supply chain and water industry
- UK government to support European technology platforms
- global recognition of DWi approval (gold standard)

Group 5:

- UKTI/SDI to prioritise
- inc use of EU funding
- lack of commercial uses for SME's
- funding for research v's managing business
- address knowledge gaps – e.g swimming pool –setting standards ahead of EU/global competitors
- increased opportunities for pilot – proof of concept/ demonstraton at local level (funds required for increased use of TSB/SBRI)
- DECC/SEPA study – e.g sand as a scarce resource! – alternative products/solutions
- are frameworks constraining innovation??
- R&D tax credit – SME – remove grants – and up tax credits!

Group 6:

- Appropriately staffed and funded sector-specific team in UKTI
- Water Utilities provide trial sites for proving technologies at home in return for a cut of overseas sales (does international ownership militate against this approach?)
- Facilitate co-operation with Atkins, Halcrow, etc. who are selling strongly overseas already
- Penetration into markets through licensing/location of agents in local territories (insurance? Funding (govt., VCs, Green Bank)? Locally based experts?)

Group 7:

- Give them loads of money!
- Identify exports markets, funding opportunities, cultural acceptance

Group 8:

- bridge the perceived gap between university projects and the delivery of reliable technology to companies.
- find a mechanism to fund technology transfer – green bank?
- joint ventures between water companies and suppliers
- Water companies acting as ambassadors for new UK technology through piloting and approving.

6: Can water markets of water stressed regions become pilot sites for future UK needs?

Group 1:

- Only with extreme events in the UK?
- Climate change... others have problems we anticipate, challenge is deciding whose model do we adopt?
- Are there technologies in water stressed markets that we might want to adopt?! Or where that we can adopt and develop to address our issues.
- Willingness to pay, product labeling, consumer awareness, education.
- Increase awareness with a similar focus as energy ratings... water ratings being encouraged through industry voluntarily. Exists already in water appliances

Group 2:

- Yes, it has the potential to become pilot sites for UK needs, but there are barriers to overcome.

Group 3:

- We can learn from elsewhere
- Tied aid is morally indefensible
- If we don't invest in known issues are we prepared to invest in the future?
- Need to define what our future needs are and do current water-stressed regions have the same problems?
- Can we import different attitudes to water?
- potential for looking at irrigation experience elsewhere

Group 4:

- Yes up to a point – demonstration of technology and gathering of data to prove the concept
- Challenge is the acceptance of the need for adoption of that approach (depends on local circumstances – market acceptance)
- refine designs – more opportunity for blank sheet solutions – can it be retrofitted
- are we more likely in the UK to adopt technology that is proven elsewhere?

Group 5:

- Yes!
- Shortage
- Domestic - e.g Anglian Water
- International- applied technologies/using biological system/wetlands
- Australia, California, Jordan Valley,
- Second use water in Spain, farm effluent
- severe contamination - Inward investment opportunity

Group 6:

- First we need to know (or at least think about) what future UK needs will be
- Look at what has/has not worked in those parts of the world closer to the edge of the 'burning platform'. Learn from successes/mistakes.
- Sell to territories with lower risk-aversion and demonstrate that 'it' does work and doesn't kill people – makes the sell to UK Water Co.s easier

Group 7:

- With difficulty. You would need a specific technical challenge.

Group 8:

- yes
- farm irrigation in east anglia is at the forefront of work in this area
- also technology for new treatment for 3rd world countries (e.g. nano-membranes)– low energy/low cost filtration and wastewater re-use
- water life-cycle management techniques could be tested in water stressed regions worldwide e.g. utilizing appropriate quality of water for irrigation of crops and optimizing the quantity of water applied to crops

Questions Set 3

7: What role does the UK water industry play in fostering innovation? What can we learn from the energy sector?

Group 1:

- Energy sector does: smart metering, CCS – major driver, PPC Regulations (BAT), more research & innovation funding? National supply system, grids, competition, mandatory supplier obligations, mandatory reduction commitments (applies to water companies also). More incentives? Critical drivers – oil & gas, climate change, historical image?
- Energy sector promotes more efficient energy generation (but easier scale to make efficiencies on?). A more 'stable', standardised industry? More modular kit, efficient maintenance.
- Innovation in products & processes
- Historically academia approaching industry, should be increasing focus on industry partnering with academia.
- Recognition and advertisement of successes by water industry.
- Longer term 'roadmaps' able to be developed, stewardship considerations.

Group 2:

- Communicate the future priorities
- Network and communication
- Co-ordinating research and innovation with academia - industry
- Greater competition – Energy Sector

- Water metering, efficiency, tariffs – Energy Sector

Group 3:

- Less than it could – Water companies are fast followers
- Less expertise in Water Companies to deal with new technologies
- Industry bodies, eg UKWIR promoting collaboration
- Energy innovation driven by price and resource

Group 4:

- set direction and aspirations – longer term than regulatory periods e.g. SDS
- identify the sticks & carrots – what levers do we need to pull to drive innovation in carbon reduction, energy consumption, solids production etc?
- provide support to test and assess new technology more effectively

Group 5:

- formerly Mouchel – TAG – ideas in front of industry for support/E investors
 - SW forward thinking on carbon footprint/embedded Carbon
 - In kind contributions to RC funding to HE sector / sponsor students
 - Industrial liaison network in industry to bring startups to industry
 - WRC – umbrella research
 - WIR – research projects?
 - Perception – not driver – but use market info/pilot/demos
- Make available demo sites for practitioners

Energy Sector:

- NRIP/Roadmapping/ETP
- Grid v canals
- Structure of industry – increase competition (telecoms)
- Customer incentives e.g. Energy saving policies and activities
- Willingness to do and fund demos – CCS
- Waste water/Algal integrated systems
- Price awareness – but can move supplier
- Has money to invest

Group 6:

- Contributions to a central ‘pot of money’ which funds innovation competitions
- A number of different models – fragmented. Innovation initiatives within OFWAT, British Water, Water UK, Water TAG, Innovation Leadership Group, UKWIR, ESKTN
- Energy sector has partnerships and mechanisms for trialling new tech in a ‘safe’ environment – no such facility exists for water/wastewater – relies on ad-hoc project-specific agreements to use live plant or redundant capacity.
- There is a community of R&D/Innovation professionals who largely know and trust each other who can come together to pool resource to undertake collaborative research

Group 7:

- a) In general terms utilities have the needs and ‘purchase’ innovative products/services etc.
- The utilities have carbon, other targets to meet.
- The supply chain must know the innovation needs and work with the users to deliver.
- Water services are set in a ‘silo’, innovation needs the holistic approach (water, energy, food, resources)
- b) Learn from their mistakes and utilise their best ideas.
- Tariff baskets and choice work for society
- More competition in energy market

Group 8:

- At the moment, water industry doesn’t play a major role in fostering innovation – tend to prefer tried and tested technology.
- Could play a bigger role through supporting development and introduction of new technology.
- energy sector is focusing on automation of delivery – SMART metering, active networks etc. Could develop SMART technologies for water management eg. Demand management, resource management
- OFGEM innovation fund – drives research and development of new technologies but question the value for money for customers in the short term. Potentially this is beneficial as it focuses on long term benefit rather than short term gains. Are there better ways?
- energy sector also has suppliers as major driver of innovation.

8: How can UK policy enable more innovation?

Group 1:

- DEFRA says not with (our) money!
- why does it have to take policy to drive step change in innovation?
- UK policy enables this through setting standards but without prescriptive processes.
- changes to the way water companies spend on research. Currently considered inefficient expenditure. Do we require a change to structure of R&D to incentivise.
- with less aversion to risk.
- 5 year AMP/Q&S cycles perceived as constraint. Longer term investments are being developed/agreed.
- Through funding allocation and flexibility. E.g. SCAMP allows deferral of capex.
- can we look at another industry/countries – e.g. medical devices – for a more innovation enabling policy?

Group 2:

- Positive involvement from government in EU policy and standards
- Setting aspirational achievable targets
- Reducing barriers in approvals procedures
- Access for small businesses to academic research facilities
- Tax credits more transparent

Group 3:

- Full implementation of water metering and charging for usage
- There is no UK policy – E&W/Scotland/Ni – amalgamation would give economies of scale?
- Consider whole water cycle rather than drinking water?
- Capital Efficiencies should generate savings for more than 5 years
- 5 year AMP periods limit innovation – 12 years from research to product
- education of public can drive willingness to do something
- remove silos in policy making – holistic and innovative thinking
- need for policy makers to be better informed

Group 4:

- **alternative industry structure** – biased towards capital solutions
- set mandatory / legislative targets on industry to drive innovation – regulatory duties on all parties
- Innovation Levy on water bills to fund Technology Innovation centre for Water
- Facilitate knowledge exchange – state of the art sharing – increases rate of adoption
-

Group 5:

- ensure follow through from research to commercialisation or change peer review for engineering committees in R Council removing 'novelty' with utility
- consider other funding structures – e.g. Finland
- extend R&D tax credits to water co. investment in SME research
- informed leadership/MSPs etc
- AMP cycle planning system not long enough/ opt to 'comfort zone' known solutions when under tight deadlines. Big utilities go at same time.
- Quick political wins not always good value for money
- joined up infrastructure/agencies – Christie Commission findings into action immediately

Group 6:

- Technology and Innovation Centres – fund better and support one dedicated to water (or something similar)
- Support Science Engineering and Technology education and link to business education
- Risk-based regulation (enabling outcomes-driven activity rather than prescriptive intervention)
- Letting failure happen (remove the stigma and other constraints around SME collapse)

Group 7:

- Financial incentives and simplified regulation
- Large and small projects required with adequate funding for SMEs
- Regulatory acceptance of risk in demonstration
- Risk/Finance shared with all parties involved (SME's, utilities, innovators etc)
- Research Council funds should go to SME's
- Step change integrated innovation needs supporting

Group 8:

- Allowing regulatory space for companies to try innovative techniques
- flexibility in standards/consents – allow piloting
- improving finance of R&D schemes into practical applications

🍷 **9: How can UK research talent be encouraged to work together and provide leadership in innovation generation?**

Group 1:

- Funding for knowledge sharing – e.g. UK WIR
- complementing rather than competing between research projects at universities. Collaboration within universities considered good but missing links with industry?
- bridging gap between academia and policymakers, industry – building better partnerships?
- better understanding of research capabilities
- Tension in IPR versus benefits of collaboration.
- Through industry/university funded research schemes.
- is there a need for an 'intelligent customer' for water industry? Awareness of emerging technologies/research in independent manner.
- not just the academics who should be driving innovation in products.

Group 2:

- Stimulating knowledge networks to small businesses
- Multidisciplinary approach in research structure
- A Scottish centre of excellence in water – one stop shop
- Embedding the right culture
-

Group 3:

- More focus on customer need and affordability
- Academic rewards are for research. Are universities best placed for development?
- Policy makers and industry should have a role – Einstein's 55 minutes to define problem
- Scientists, engineers and commercial need to work together
- Education can create pull

Group 4:

- Knowledge Transfer Partnerships
- Themed Industry Lead Grand Challenges – funded from Funding Councils and Sector Fund
- Define the problem that you are trying to solve – e.g. chlorine free treatment, zero leak networks

Group 5:

- Bring back industrial case awards
- Talent Scotland – needs better marketing
- Placements/interns U/G
- KT..etc not part of the day job!
- Senior Leadership/KT Dept in Universities can undermine commercialisation
- new HE landscape may deliver unintended outcomes

Group 6:

- 'All of the above'!
- Certainty of outcomes for somebody – well-funded calls for carefully-defined outcomes that encourage collaborative submissions (sandpits?)
- EEN- type 'Offer-Need exchange' (ESKTN?)

Group 7:

- Personnel secondments/placements into supply chain and utilities
- Adequate funding
- Make KTPs more affordable to SMEs
- Initiate an open "UK Water Innovation Conference/Forum" specifically to discuss regularly new ideas, research, opportunities etc.

Group 8:

- multi-disciplinary research
- co-ordination of UK research – STREAM type approach
- Water innovation platform funding

- water company involvement in delivery
- raising awareness of problems to be solved to engage researchers

Questions Set 4

10: What funding models will be most beneficial to facilitate invention, proof of concept and technology transfer in a high risk/high gain industry?

Group 1:

- Question: is our industry high risk, high gain?
- TSB operates innovation platforms
- Schemes for R&D investment exist ...
- Tiers – Government (strategic), Regulators (operational), Water Companies, UK Research Council, Suppliers.
- Funding that includes greater commitment from industry.
- Ideal model – water company provides a supplier with £ for specific R&D but this isn't possible.
- Are funding models long term enough?
- Challenges of testing new products given variation in our raw material – water.
- Difficulty of installing/acceptance of new technologies by regulator/water companies.

Group 2:

- Collaborative, open innovation funding model
- Structured stage gate approach
- Shared risk funding
- Protection of IP - important factor

Group 3:

- High risk / low gain – high gain would drive innovation
- Capital Efficiencies should generate savings for more than 5 years
- Allow longer payback periods
- 5 year AMP periods limit innovation – 12 years from research to product
- Loss of Regional Development Agencies and move to TSB has lost local knowledge of SMEs and local requirements
- Does municipal vs private water company drive more innovation (USA)
- French model of vertical integration (supplier and municipal operator) allows large R&D spend, development and commercial product – lack of competition (globally)
- French operational contract periods are longer than UK regulatory periods – take a longer view on holistic solutions and payback periods. Does PFI offer the same?

Group 4:

- centrally funded from levy / tax on bills or company profits?
- incentive mechanisms need to recognise long term nature of R&D / Innovation to adoption
- remove geographical averaging of charges – incorporate energy costs etc.

Group 5:

- Copious options not well understood
- Enterprise Investor Scheme worked – founders and investors
- incentives
- problems – experts to fill in the forms, /politicians/civil servants don't understand the technology
- design of funds doesn't reflect practicalities of 'research processes' – dumbing down and loss of innovation!
- Tendering constraints – where only one provider slows implementation/use/innovation
- Fraction of water bill ring fenced funding for R&D

Group 6:

- Which industry are we talking about? Water is not characterized by high risk/high gain. So long as we sell water for pennies where is the reward potential?
- Venture Capital – where there is an acceptance of the Venture element.
- De-risking investments through thorough technical due-diligence.
- Dedicated fund for innovation in the water sector (a la Cave/CST report)
- 'SMART' style funding for riskier early-stage r&d pre-proof of concept (a la Scottish Govt.) Paid for by ...?

Group 7:

- Rewrite question - What funding models will be most beneficial to facilitate invention, proof of concept, technology transfer and **demonstration** in the water industry in a **low risk/medium** gain industry?
- A model that shares risk, finance and benefits

- EUREKA programme model – works well in rest of Europe

Group 8:

PROBLEM / QUESTION ID

Funding – not just the money available but how it is used. It's the doubling of costs associated with fees and additional consultancy layers. High amounts of administration

Concentrate on the delivering value for money concept at start of process combined with innovative processes. This is more a private sector behaviour where values for money is the priority as opposed to current water sector.

Innovation by small private companies/supply chain are not championed by public sector.

It's the gap between the tried and tested processes which companies prefer to support and the new processes and the issue is that the public companies don't always want to support these process become the tried and tested. Try to push costs on to company.

Different objectives – how to generate the financial return within short timescales.

Holistic interpretation of drivers re compliance – e.g. variable consents. The fixed interpretation of consents drives the wrong solution which isn't cost effective – don't just keep tagging on new treatment processes for one parameter when actually changing the overall treatment process could be more effective and cheaper.

SOLUTION

What funding models work?

Project delivery partnership approaches to development of innovative processes and projects.

Regulatory regime able to accommodate risk. Companies don't always want to innovate as if the process doesn't work the companies have to pay to put it right. Link with the flexible interpretation of standards taking into account specific circumstances.

TAG group (Pierce Clark) combining small company exposure to utilities with investor funding. But here must ensure that there are good ideas. Often the companies don't come through.

Water innovation park – to test the product / innovative solutions. Research council funding involved here.

Bank borrowing difficult for innovative technologies, private equity used instead. Then when business/ process more established bank finance becomes available. Need something in the middle of this as well as early research council funding.

Use looser contracts not just water quality goal use sustainability goals. German model.

Project implementation – models design, build, own and operate get the method right as this does not always drive innovation.

Finance may be supplied by new players in the industry e.g. power industry and non-household side in Scotland. This has driven innovation perhaps more of this.

Market structure is based round big consultancies and legal operations. Design consultancies aren't often making any money – they don't invest and innovate. If a mechanism could be found to facilitate consultancies to work more with research and suppliers this could help.

11: How to support spin off, capital investment and business strategy in the gap between proof of concept and full roll out?

Group 1:

Constraints of 5 year program – supporting structure needs to enable growth/support beyond 5 years.

- gap in UK technology development vs. adoption.
- exporting/development of technology outside of water sector (e.g. industry)
- Through improved advertising/more consumer awareness.
- Mechanisms for funding: markets, industry,

Group 2:

- Demonstration facilities – test beds
- Support through exhibitions, workshops, conferences
- Framework for new businesses to meet investors and collaborators

Group 3:

- Business incubation – provision of business infrastructure to allow focus on technology development
- Water companies and supply chain need to be involved (licencing)
- accept risk of failure
- Regional facilities for testing of technologies – north/south divide

Group 4:

- national demonstration centres – single national body – shared results – rapid testing of technology
- bridge the gap between academia / proof of concept and pilot scale
- Visibility of the short/medium term objective and long term objectives for industry

Group 5:

- First tens years of corporation tax on dividends only – timing hits at time when needed for investment
- VC looking at MB not start-ups
- All investments funds managed by VC with public money should not have preferential exit clauses

Group 6:

- 'SMART funding' Phase II.
- Collaborative trials – group investments from water companies
- Access to operators, live assets, etc.
- 'WaterTAG'-type approach. Third-party due-diligence for investors – signals for potential funders.
- Early-stage commitment to buy ('forward-commitment procurement' approach). Championing of concepts and technologies.

Group 7:

- Water specific incubation centres
- Capital return in catchment management, water supply, wastewater and environment long term e.g 5 years min
- 95% spins out company close down mainly because short term return required by VC's
- Demonstration budgets
- Major innovation prizes

Group 8:

- Research councils don't fund enough applied research. They could support this more.
- Academics – financial targets and industry engagement – technical leadership would be raised here.
- Do business leaders come out of University? Transition of scientists/engineers to business.
- Universities need to link up with relatively early stage companies perhaps with research council or development agency support.
- Use some of the money which is used for legal contractual commitments to fund innovation. Perhaps introduce a % levy to fund the technology to support innovation.
- Could a levy or landfill tax approach be applied?
- Ofgem – went down an innovation fund route. Companies then come forward with scheme proposals. There are incentives on the companies to innovate. Should financial incentives be used. – e.g. companies recover money for sustainable/innovative solutions. But there are problems with this and benefits are not always transferred to the customer.
- Agriculture levy on sale of agricultural produce used to fund near market research. Issue here is where does the money go? Would need to be different to current UKWIR research priorities.

🍷 12: What are the skill requirements of our future water technology leaders?

Group 1:

- 'Green economy skills' including knowledge of resource efficiency
- Environmental/financial accounting
- Communication/marketing skills for scientists/technology leaders.
- Improved communication and relationships with public and media.
- Attitudes to promote a better image for the industry - bad publicity is largely the only publicity that makes the news
- Improved practical experience for university graduates during studies.
- Improved industry education.
- Addressing knowledge/experience gap (in operations).
- Structure required for innovating youth to be developed/educated by the more experienced. Knowledge transfer.

Group 2:

- Flexibility, right blend of technical – commercial expertise
- Leadership and clear vision
- Practical knowledge of the industry
- Accept failure as an option and celebrate success

Group 3:

- Commercial awareness
- Interdisciplinary understanding / approach
- Educators, influencers and communicators
- Political astuteness
- Visionary
- Global view

Group 4:

- Process & bioprocess engineering skill set
- Systems engineering – water, energy waste
- holistic planning / sustainable living professionals

Group 5:

- entrepreneurship
- ensure Boards have broad base of skill – but in particular technical capability
- risk taking – piloting
- ‘big picture’ cross sectoral capability
- Receptive to global best practice and desire not to reinvent the wheel

Group 6:

- Greater multi-disciplinarity, chemists, chemical engineers and not just civils (or at least civils with a knowledge of chem.)
- The ability to communicate their ideas simply and clearly
- Assessment of risk appetite and appropriate tolerance of uncertainty. Willingness to give things a try. Empowerment of individuals to suggest new ways of working.
- Holistic view. End-of-pipe is not always the answer.
- Political awareness, financial awareness,
- Breadth of technology awareness to prevent technology lock-in
- Fluent Mandarin speaker

Group 7:

- We require visionary leaders not constrained by investors or previous practices.
- Leaders need to manage the nexus of water – energy - waste
- Willingness to collaborate outside of water.

Group 8:

- Develop technical leadership. Skills mainly commercial. Water companies not the ‘intelligent’ client they used to be?
- Reliant of mainland Europe skill base need greater training of UK. Small companies don’t have the resources to employ graduates. Training people to shift from declining markets to growth markets e.g. AD.
- Engineers perceived to like a traditional solution – need education for sustainable solutions and use of novel materials etc. More experience of interdisciplinary projects and University.
- Life cycle costs and carbon costs of investment skills will drive innovation.
- Driving innovation into new materials

Summary Discussion Notes:

- ◆ Societal challenges to justify expenditure, Revisit in 3yr; What are the real drivers to innovate (electricity industry: drive down the carbon)
- ◆ Climate change/carbon/micropollutants: get in there early to talk to Brussels before it generates its own life; innovation to shape our own future rather than react.
- ◆ Other sector have league tables/metric measure to measure performance (energy, etc): create market through a big stick and carrot to reduce cost. Current way of operation in not to use carrots/sticks. Ofwat trying to get companies to be own judge of performance. This approach worked very well for 20yrs so carry on....what can change to drive innovation? Imposing targets to get better on certain metrics; the targets will eventually drive innovation. GHGs why innovate on emissions; change culture by collaborating in semiconductor industry rather than regional monopoly. Bring back WRC? Micropollutants: leading on wastewater side research (?). If precautionary compliance/regulation we may drive GHG? Investment fits purpose vs global responsibility to invest to save lives. Cannot continue the borrowing/debts. Careful definition of problem, unforeseen consequences of getting the problem wrong. League tables do not work: assumes level playing field, energy efficiencies will vary depending on pumping contribution etc [what if unit operation specific?]
- ◆ League table does not make sense unless industry driven (wants them) and it is voluntary.
- ◆ Gold plating: global technology approval process for technologies; Technology advisory groups: event for SMEs to showcase technologies; TSB technology demonstration events.
- ◆ Yearly Water Innovation Congress; Beddington UKWIF will address this? Feed back in this direction useful (Defra).
- ◆ CIWEM happy to let other people know. KTN offer website for technology showcasing(?), Hydronation responses are on SW website; next steps not clear yet. Feed back outcomes of today to Scott Govt (Linda Pully ob Irvine ...)
- ◆ Short definition of problems: pulls together ideas; intranet/blog site to pull together ideas rather than heavy face to face meetings/conferences. KTN website? One stop shop.